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cation of being expressed for the purpose of conveying to others thought on the part of the utterer. When birds are nest-building I have shown that the subject of future requirements is duly considered, when *the thought* occurs to the busy birds, and is acted upon by both, after its necessary communication by one to the other, in an intelligent manner, thereby demonstrating a cerebral action identical with that of man when analogously circumstanced. I have endeavored to show that cunning on the part of crows was largely acquired, and differed in individuals, showing a variation in brain power, and also that their association was too well organized to be looked upon as other than one where there were some superior intellects to guard the interests of their masses. Finally, we have seen that the ordinary physiological effects of alcohol, such as obtain in man, render birds liable to drunkenness when they unwittingly indulge too freely; and just as their brains, as do human brains, respond to its effects, so there is also abundance of reason for believing that insanity, too, may arise from just such causes as produce this malady in man.

Thus, rapidly glancing over the range of bird-life, in its feral state and in confinement, in health and in disease, we may see that much that is often thought peculiar to mankind is partially, also, an attribute of birds. We must, if disposed to see all animate nature with unbiassed minds, grant to these lower forms a higher grade of intelligence; and if, as yet, we cannot bridge the chasm that separates us from them, it is not so much that the chasm is too broad as that our pride and ignorance vainly supposes it to be wider than it is.

THE AGE OF THIS EARTH.

BY H. P. MALET.

AN able article in the *Quarterly Review* for July, 1876, gives the calculations of several sciences, differing from one another by tens and hundreds of millions of years, on the age of our cosmical system.

Physical geography was not represented; we claim for it not only as great a knowledge of facts in reference to the main point as any other science possesses, but the means of enabling us to point out where other sciences seem to be in error as to time, to data, and consequently in their complex calculations.

Mathematicians are so correct in their figures that when they start from one point to reach one end, their ends ought to be the same; when these ends vary and we find no fault in the calculation, we must look into the data for the cause of variation and error.

The article alluded to gives us an outline of cosmical beginnings from the theory of Laplace, published in 1796 (Maunder). Astronomers had been aware that many nebulæ floated in space; these became "specimens of worlds in making," under the powerful telescope of the French astronomer. As the nebulæ became denser, they came under "the action of gravity;" consequently "a succession of rings, concentric with and revolving round the centre of gravity," were formed. "Each ring would break up into masses, which would be endued with motions of rotation, and would in consequence assume a spheroidal form. These masses formed the planets, and gathering with energy round its centre formed the sun." It is then explained "that the earth could not have had an independent existence till long after that time . . . for before then the earth must have formed part of the fiery mass of the sun;" the *Quarterly* observing, "Thus, probably, was the world we live in and the solar system of which we form a part evolved out of chaos."

Science has proved that motion causes heat, and therefore the sun was provided with a supply by the action of the nebulæ. If they were cold when they came together,—the only condition they could have been in,—the supply of heat was calculated to last for 20,250,000 years at the present rate of consumption. Thus "the dynamical theory of the sun's heat renders it almost impossible that the earth's surface has been illuminated by the sun's rays many times ten millions of years; and when we consider underground temperature, we find ourselves driven to the conclusion that the existing state of things on the earth, life on the earth, and all geological history showing continuity of life must be limited within some such period of time as 100,000,000 years." This authority, Sir William Thomson, is reported to have told the British Association at Glasgow that "50,000,000 years is an even estimate" for the age of this earth.[1]

A comfortable margin of fifty per cent. seems convenient to the precise sciences. Professor Tait is reported to have said in a late lecture at Glasgow, in alluding to differences on this subject, "So much the worse for geology as at present understood by its chief authorities, for physical considerations render it impossible that more than 10,000,000 or 15,000,000 of years can be granted." Before entering on physical details it will be as well to point out a curious question between mathematicians and geologists in reference to "under-ground temperature." Some geologists assign all igneous action on this earth to local chemical causes; but the fashionable school allows its ignorance on this subject in the Text-Book of Geology, by Mr. Page, seventh edition, page 51: "The occurrence of volcanoes, earthquakes, escapes of heated vapors, and thermal springs are by far too numerous and general to be accounted for on any principle of chemical union with which we are acquainted." In other words, the expenditure of heat from the earth is supposed to be more than local chemical causes could supply. Mathematicians give "20,250,000" years of heat to the sun; as this earth is supposed to have been an offshoot from its "fiery mass," we may infer that when the earth was detached it must have been in the same hot condition as the parent mass. Mr. Proctor gives us the diameter of the sun at 850,000 miles, and Guyot's geography gives the diameter of this earth at eight thousand miles. If, then, the diameter of the sun contains heat for 20,250,000 years, the diameter of this earth can hold heat only for 190,588 years. We know nothing of fresh supplies of fuel to earth or sun, in reference to the theory of Laplace; we give the sun the credit for greater expenditure of heat than the earth; but if geologists are right in supposing that local chemical causes have been unequal to the earth's expenditure, and that this has been going on for ten, twelve, fifty, or one hundred millions of years, according to the calculations of physical science, we may wonder why the internal fire did not become bankrupt long ago. We may also remark, in passing, that if igneous action is of any advantage to this earth, it is lucky that neither science had any hand in its origin.

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[1] The Mail, September 8, 1876.

It was pointed out by the German metaphysician, Kant, and has been accepted by others, that there has been a retardation of the earth's revolution from the tidal wave. The conclusion, as given in the *Quarterly*, is, "She was rotating at about the same rapidity as now when she became solid, and as the rate of rotation is certainly diminishing, the epoch of consolidation cannot be more than ten or twelve millions of years." This calculation cannot be of much consequence to the cosmical system; but as no one knows how the tidal wave acted before there was land for it to flow and ebb upon, we put the theory down as useless, and accept the tidal action as a part of the dynamical action, that helps to keep the whole sphere in equilibrium.

We now come to a mixture of mathematics and geology. The late Sir Charles Lyell, calculating from the present growth of the dry land, put the age of this earth at 300,000,000 years, the fossiliferous strata at 240,000,000, and the Glacial epoch at 1,000,000 years ago.

The earnest and accurate mathematician, Croll, endeavors to modify the geological epochs by a calculation "at once beneficial, simple, and complete. . . . The land has been many times under the sea, and the most violent changes of climate have succeeded one another." Causes are produced to show "that every ten thousand years, or thereabouts, the winter of the northern hemisphere will occur, . . . whenever any records are left of the Glacial epoch, a general subsidence of the land followed closely on the appearance of the ice, . . . the extent of submergence will be in proportion to the weight of ice, . . . glaciation would be transferred from one hemisphere to another every ten thousand years. There would be elevation of the land during the warm period, and subsidence during the cold."

The article goes on to tell us that "the discovery of Mr. Croll upsets the whole scale of geological time." Croll gives four periods of glaciation, the last of which was 200,000 years ago; so that the Glacial period is reduced to that age, the date of the fossiliferous rocks to 48,000,000, and the age of the earth to 60,000,000 of years.

All glacial epochs are supposed to have left their marks behind them. Croll says they occur every ten thousand years, but the writer of the article has left out twenty of these periods, and selected one of Mr. Croll's without knowing whether Sir Charles Lyell referred to that particular period or to another which Croll tells us took place 850,000 years ago. As figures go in this matter, Sir Charles would have a very small margin of 150,000 years if he worked on the traces of this period. The writer of the article seems to have had an object in his figures by reducing them as nearly as possible to his own.

We must now consider two more facts brought forward by Croll in support of his calculations: —

First: "The land has been many times under the sea." . . . "The submergence will be in proportion to the weight of ice." The latter quotation cannot be proved; ice vanishes, and its weight cannot be known. Submergence of land takes place all round the world. The causes are soft foundations and growing superstructures, pressures, sinkings below water, sedimental gatherings, gradual risings, and the repetition of the same actions till a solid foundation is secured. When foundations are undermined by subterranean water action, submergences of surface areas occur suddenly, and the rising again is uncertain.

Second: "Violent changes of climate have succeeded one another." Opinions vary as to the cause of this in the arctic regions. Some follow Mr. Croll in his see-saw theory, or the oscillation of the poles. If it takes place, changes of climate must ensue; but a very material point seems to have been forgotten, — if the oscillation is cosmical the water would go down with the land, there would be no submergence. There would be ten thousand years of ice and ten thousand years of warmer climate. These changes would be general, but the fossils of warmer regions do not prove a general growth, neither do the warm-region drifts of the present prove a general action through the arctic regions. In the late arctic expedition it was colder on one shore of Smith Sound than on the other; and Captain Sir George Nares gave this experience of the Arctic and Atlantic Oceans to the Royal Geographical Society.

In the Atlantic Ocean there is "an enormous reservoir of heat." This warm water is forced "gradually towards the northward and eastward, modifying the climate of all parts lying in its course. There is also a warm current ever running to the northward through Behring's Straits." These warm supplies run at present through certain channels, while in other channels "an icy cold current" runs to the southward. The polar basin has a "warm stream of water constantly pouring into it between Spitzbergen and Norway, and a cold icy one as constantly running out between Spitzbergen and Greenland, also . . . between Greenland and America; . . . so great is the difference of climate caused by these powerful distributors of heat and cold that the temperature of the sea . . . twenty-two hundred miles from the equator is precisely the same as that nearly double the distance from the equator."

As we have these cosmical actions, guided by fixed cosmical laws, perpetually circulating the heat and the cold, — not always in the same channels, but distributing both according to the direction of either current, — we find a certain cause for the "violent changes of climate" alluded to, instead of the more than uncertain oscillation with the doubtful results of Mr. Croll. We cannot agree with the author of the article in the *Quarterly*, or allow that this Glacial theory in any way interferes with geological time as laid down by the late Sir Charles Lyell. Having thus disposed of certain details as to the age of this earth, we must now briefly consider the position of our geological science on this point.

Properly speaking, geology is a discourse of things on or in the earth, of things tangible and visible. Geologists in accepting the theory of Laplace, make the foundation of their science neither tangible nor visible. It suited geology to adopt it because, in the prevailing ignorance of natural laws, it seemed to explain the causes of certain phenomena. Now that a more accurate knowledge of cosmical law is creeping up, there is no excuse for adhering longer to a theory which is incapable of explaining the cause of igneous phenomena on or in the earth, while it is made ridiculous by the little figures of the mathematicians.

We cannot meet the dogmas of science on this subject because we think with a finite mind on an infinite beginning; but we ask geologists and mathematicians to follow us through a brief tracing of the cosmical laws and their actions from that beginning, as far as that has been revealed to us till now.

There was a void chaos of waters without form, and dark; how long this earth remained in this condition we do not know. A water-bed was formed, light was given, motion, day and night ensued, revolution of the earth on its axis had commenced and continued to this sphere its hours of labor and of rest. Another result followed the presence of light: water was attracted by it, as it is to-day; the water clouds were collected in the firmament, and were divided from the waters under the firmament; all this law is in force now, but no one can say how long a time elapsed before the action became perfect and complete.

As the light caused a movement in the waters, so the waters acted on their bed. No one can say where the general level of that early bed was. But as it deepened from the ever-acting erosion of the waters, they were of necessity gathered unto one place, and the bed which they had rested on became dry land.

No science can tell when this happened; we do not know where the first water-level was, the level of the dry land or its locality; no one knows when light first shone upon earth, or when it first divided the waters; we cannot say how long the atmosphere and the water were occupied in forming the silicious nucleus of our earth, but we know that it gives silicious matter now. We cannot tell when the water was separated from the atmosphere, or how long the atmosphere retained in itself the elemental constituents of water and of earth. The mathematician and geologist have nothing to do with the subject before this event took place; there is nothing visible or tangible, no data for a single figure. The moment dry land is created the physical geographer begins his labors. They are not difficult; he knows the uncertain forces that work under cosmical laws on forever changing materials; by knowing the results at present, he can tell those of the past. Far be it from us to suggest infallible action; we can but give a faint outline of the whole, but we give nothing that cannot be verified by the law and its actions at the present moment.

The geographer looks through time upon the face of the first dry land; he sees the water-sheds giving out their little trickles all running down the slopes, all wearing away something in their course, all depositing some atoms on their way, and all carrying on to their little estuaries or deltas a constant succession of minute atoms. He sees the deltas constantly extending by the addition of atoms, and constantly rising in consequence of the retiring of the waters. He sees constant additions to the dry land made by the water in one place, and constant abstractions in another; he knows that every atom taken from the water-bed makes that bed deeper, and every atom taken from dry land helps eventually to extend its shores.

Under these actions he comprehends that the dry land must have gone on growing, and that the undulating ocean bed must have grown deeper where its currents ran, and shallower where they did not; he traces the gradual growth of these shallow places, not by any forcible elevation of the mass, but by the slow departure of the water, by the sediments left upon them, by the eventual growth of vegetation, by the creation of life, by the elemental forces forever returning to their dusts, in some regions or another, to the extending deltas and the growing dry land.

He looks upon the mud and sand-banks of to-day and sees the same forces at work under the same laws; he knows that these forces acted under the same laws at the beginning, and he knows that they acted on the materials then available as they act on the materials of to-day. He marks through legends, history, and his own experience the denudations and the additions of the seashores; he finds that in thousands of years the general contour of the dry land has remained the same; he finds that localities have been added to and taken away. In these subtractions he sees the fossil remains of prehistoric organic structure torn from their resting-places in the calcareous rocks, he handles the flint nodule formed from the silicious dusts of diatoms and foraminifera, and finds the same dusts in course of deposit in the deepest parts of the ocean, telling him, not only that these organisms have continued their races for millions of years, but that they have, for all those ages, left their dusts to subside upon the ocean bed, certain evidence that the site on which we find the stratified calcareous rocks, with their lines of flint nodules, was once the ocean bed. He may look on the sand collections now on our surf-beaten shores, on the wind-drifts of the great deserts, and on the sand-dunes in many regions; he does not know when they began to grow, but he sees on mountain sides sandstone rocks several hundred feet in thickness, many miles in length and breadth. He knows that they were formed and gathered by the same forces that now occupy hundreds of years in adding a few inches to the shores, and he is lost in thinking of the vast amount of silicious matter broken up, triturated into sand, and deposited by the water on its bed, and that bed hundreds of feet above his head. He finds the hard silicious rock in stratified form on the tops of our highest mountains, in their interior, and in the deepest seas, where it still wears away and contributes atoms for deposit in other places. He is lost in the time occupied by the deepening of the sea, by the vastness of the deposits formed by it, far above its present surface level, and by the extent of deposit now in progress in its depths. The geographer knows that every river is always bringing something to its estuary, yet its growth of dry land is very slow; he measures it, but he cannot tell by that measurement when the estuary of the Nile was four thousand miles from its present site. He may trace the Mississippi from its present watery delta back to its tributaries in the Rocky Mountains, but it does not tell him when these, now great, waters trickled as little rills from the first dry land of those regions. He looks upon the water-worn chasms of the Himalayas and the Alps, on the vast gorges of great rivers; he cannot say when those rivers began to run, or how long it took them to wear away the hard obstruction to their course, any easier than Sir Charles Lyell could tell the age of the Niagara Gorge.

He may see the vast structure of the coral insect [*sic*] now growing over thousands of miles in the Red Sea, but he does not know when those structures were commenced. He sees the stupendous mass of the dolomite mountains: he knows that these were all lodged as sedimental matter where they now stand by the same water forces which had previously built up the silicious Alps; that all the materials of which they are formed were brought atom by atom, just as atoms are lodged on our sea-coasts to-day, by the waters, which were then deeper than the mountains are high, from places on the sea-bed which were shallower, places that were washed away, and deepened by the very force that broke up the coral banks, carried them away, and lodged them where they are. He can form no idea where or when the insects lived that gathered all this calcareous matter from their water, how long it occupied them in constructing their palaces, how long they existed, when they were pulled to pieces, how long they were triturated by current and by wave, or when the atoms were permitted to become deposits.

He may look on the calcareous matter of the Jura Mountains and know that they are formed from bones and shells of a fauna that once lived on land or in the water; he knows that these masses were lodged in water as deep as the mountains are high, in minute fragments, with an occasional entire shell or an unbroken bone, but he knows nothing of the land or water in or on which the fauna lived. He cannot count the time occupied in the formation of these mountains, or tell for how many ages the fauna lived that left their dusts to form them. Wherever the physical geographer turns he is lost in the lapse of ages. The waters have left their old beds, the land has acquired new dimensions. All dry lands have their high places, from which their water-sheds convey their atoms away; every atom helps to extend dry land; the water-sheds are the agents for the work, and the great waters are the agents for the separation of matter, and for its deposit in its proper place. All this is done now under certain laws by the cosmical agents, air and water.

No one knows better than the physical geographer the truth of the words used by the writer in the *Quarterly Review:* "In all the operations of nature . . . God worked by law, . . . by the process of slow development, by means beautifully simple, involving no violence, no haste, yet irresistible." No one sees more clearly the error, ascribed to Professor P. G. Tait, in *The Mail*, 8th January, 1877: "The present state of things has not been evolved through infinite past time by the agency of laws now at work, but must have had a distinct beginning." "When was it, and what was it?"

It is the slow, the certain, the beautiful, and the unchanging process of cosmical law, which gives the character of infinite to the universe. Finite man has not as yet read the pages of the law, and cannot therefore calculate the age of this earth. He has tried over and over again to do so, but Professor Tait is not so near to the truth as Solomon was; other "guesses" (*Quarterly*) may be nearer, but the men who guess are at present without chart, compass, or sounding-line on the fathomless and boundless ocean of eternity. — *The Geographical Magazine.*

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EVOLUTION IN THE NETHERLANDS: TESTIMONIAL TO MR. DARWIN.[1]

WE have great pleasure in printing the following correspondence: —

UTRECHT, *February* 20, 1877.

TO THE EDITOR OF NATURE, — On the sixty-ninth birthday of your great countryman, Mr. Charles Darwin, an album with two hundred and seventeen photographs of his admirers in the Netherlands, among whom are eighty-one doctors and twenty-one university professors, was presented to him. To the album was joined a letter, of which you will find a copy here inclosed, with the answer of Mr. Darwin.

I suppose you will like to give to both letters a place in your very estimable journal, and therefore I have the honor to forward them to you.

P. HARTING,
Professor, University, Utrecht.

ROTTERDAM, *February* 6, 1877.

SIR, — In the early part of the present century there resided in Amsterdam a physician, Dr. J. E. Doornik, who, in 1816, took his departure for Java, and passed the remainder of his life for the greater part in India. His name, though little known elsewhere than in the Netherlands, yet well deserves to be held in remembrance, since he occupies an honorable place among the pioneers of the theory of development. Among his numerous publications on natural philosophy, with a view to this, are worthy of mention his "Wijsgeerig-natuurkundig onderzoek aan gaande den vorspronkelijken mensch en de vorspronkelijke stammen van deszelfs geslacht" (Philosophic Researches concerning Original Man and the Origin of his Species), and his treatise,

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[1] From Nature, London.